

In re Patent Application of:  
YAO  
Serial No. 10/736,859  
Filed: 12/16/2003

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Amendments to the Claims

1. (original) A photodiode comprising:
  - a) a semiconductor intrinsic light absorption layer having a thickness  $t_i$ ;
  - b) at least one of a p-doped light absorption layer and an n-doped light absorption layer;  
wherein the p-doped light absorption layer has thickness  $t_p$  and the n-doped light absorption layer has a thickness  $t_n$ , and wherein  $(t_p + t_n)/t_i$  is greater or equal to 0.17, wherein  $t_i > 0$ ; or  
wherein at least one of the p-doped light absorption layer and the n-doped light absorption layer have a doping concentration of  $d_c$  between  $1e16$  and  $5e18 \text{ cm}^{-3}$  and wherein the concentration of any doping present in the intrinsic layer is  $3e15 \text{ cm}^{-3}$  or lower; and,
  - c) a cathode electrode and an anode electrode electrically couple with the n-doped light absorption layer or the p-doped light absorption layer, respectively.
2. (original) A photodiode as defined in claim 1 wherein  $(t_p + t_n)/t_i \geq 0.20$ , and wherein both the p-doped light absorption layer and the n-doped light absorption layer have a doping concentration of  $d_c$  in between  $1e16$  and  $5e18 \text{ cm}^{-3}$  .
3. (original) A photodiode as defined in claim 1 wherein  $t_n = 0$
4. (original) A photodiode as defined in claim 1, wherein  $t_p = 0$

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5. (original) A photodiode as defined in claim 2 wherein  $(t_p + t_n) / t_i \geq 0.45$ .

6. (original) A photodiode as defined in claim 1 wherein the dopant concentration  $d_c$  layers is in between  $1e17$  and  $2e18 \text{ cm}^{-3}$ , while the intrinsic layer has doping below  $5e14 \text{ cm}^{-3}$ .

7. (original) A photodiode as defined in claim 2, wherein the semiconductor intrinsic layer and the at least the p-doped light absorption layer or the n-doped light absorption layer are sandwiched between the cathode and anode electrodes.

8. (original) A photodiode as defined in claim 2, wherein the light absorption layers consist a p-doped light absorption layer, and the intrinsic light absorption layer, said layers being adjacent to one another.

9. (original) A photodiode as defined in claim 2, wherein the light absorption layers consist an n-doped light absorption layer, and the intrinsic light absorption layer, said layers being adjacent to one another.

10. (original) A photodiode as defined in claim 1, wherein the total thickness of the doped and intrinsic light absorption layers is greater than  $v/(2f_{3-\text{dB}})$  by 20% or more, where  $v$  is the saturation drift velocity of either the electron or the hole, whichever is smaller, in the intrinsic light-absorbing layer, wherein  $f_{3-\text{dB}}$  is the frequency at which the amplitude of responsivity of the photodetector is reduced to  $1/\sqrt{2}$  of its DC low-frequency value.

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11. (original) A photodiode as defined in claim 6, wherein the total thickness of the doped and intrinsic light absorption layers is greater than  $v/(2f_{3-\text{dB}})$  by 20% or more, where  $v$  is the saturation drift velocity of either the electron or the hole, whichever is smaller, in the intrinsic light-absorbing layer, wherein  $f_{3-\text{dB}}$  is the frequency at which the amplitude of responsivity of the photodetector is reduced to  $1/\sqrt{2}$  of its DC low-frequency value.

12. (original) A photodiode as defined in claim 8, wherein the total thickness of the doped and intrinsic light absorption layers is greater than  $v/(2f_{3-\text{dB}})$  by 20% or more, where  $v$  is the saturation drift velocity of either the electron or the hole, whichever is smaller, in the intrinsic light-absorbing layer, wherein  $f_{3-\text{dB}}$  is the frequency at which the amplitude of responsivity of the photodetector is reduced to  $1/\sqrt{2}$  of its DC low-frequency value.

13. (original) A photodiode as defined in claim 1, wherein the presence of the p-doped or n-doped absorption layer increases by 20% or more the responsivity  $\times$  bandwidth product over a p-i-n consisting of an anode a cathode and an intrinsic layer sandwiched therebetween under the same temperature and bias conditions.

14. (withdrawn) A photodiode as defined in claim 1 including an avalanche multiplication layer, wherein the responsivity  $\times$  avalanche-multiplication-gain  $\times$  bandwidth product exceeds by 20% or more the responsivity  $\times$  avalanche-multiplication-gain  $\times$  bandwidth product of a same diode in the absence of said doped

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absorption layer under the same temperature and bias conditions.

15. (withdrawn) A photodiode as defined in 14 having a separate absorption and multiplication layer.

16. (original) A photodiode as defined in claim 1 with a 3-dB bandwidth frequency of 40GHz or higher, wherein the doped and intrinsic absorption layers are InGaAs lattice-matched to InP, and the total thickness of the doped and intrinsic light absorption layers is greater than 0.60 microns.

17. (original) A photodiode as defined in claim 1 with a 3-dB bandwidth frequency of 40GHz or higher, wherein the doped and intrinsic absorption layers are InGaAs lattice-matched to InP, and the total thickness of the doped and intrinsic light absorption layers is greater than 0.65 microns.

18. (original) A photodiode as defined in claim 1, having a 3-dB bandwidth frequency of 40GHz or higher, wherein the doped and intrinsic absorption layers are InGaAs lattice-matched to InP, and the total thickness of the doped and intrinsic light absorption layers is greater than 0.70 microns.